II. "Note on the Existence of a Milk-curdling Ferment in the Pancreas." By William Roberts, M.D., F.R.S., Physician to the Manchester Royal Infirmary. Received May 10, 1879.

In the course of some observations on the digestion of milk by extract of pancreas, I found that the milk passed through a more or less pronounced phase of curdling, which often considerably delayed the complete peptonising of the casein. As the property of curdling milk has hitherto been regarded as the special appanage of the gastric ferment, I was unprepared to find it also associated with the ferments of the pancreas. There is, however, no doubt about the fact, at least in regard to the pancreas of the pig, the ox, and the sheep.

It was found that extract of pancreas made with saturated solution of sodium chloride had much stronger curdling powers than the glycerine extract, whereas the latter had stronger proteolytic powers than the former. This indicates that the curdling ferment of the pancreas is distinct from the proteolytic ferment (the trypsin of Kühne), just as it has been recently shown that the curdling ferment of the stomach is distinct from pepsine.

The brine extract of pancreas, or pancreatic rennet, as it may be called, seems to act on milk exactly in the same way as rennet made from the calf's stomach. It coagulates casein actively, both in neutral and in alkaline milk, and it may be assumed as probable—at least until further inquiry—that the curdling agent of the stomach and the curdling agent of the pancreas are one and the same ferment.

III. "On some Recent Improvements made in the Mountings of the Telescopes at Birr Castle." By the Earl of Rosse, D.C.L., LL.D., F.R.S.

(Abstract deferred.)

IV. "The Measurement of the Ratio of Lateral Contraction to Longitudinal Extension in a Body under Strain." By A. Mallock. Communicated by Lord Rayleigh, F.R.S. Received May 17, 1879.

The three coefficients which define the elastic properties of isotropic solids, viz., the simple rigidity (n), Young's modulus (q), and the elasticity of volume (k) are connected by the equations

$$2n(\mu+1)=q=3k(1-2\mu).$$

The quantity μ or the ratio of lateral contraction to longitudinal extension, the measurement of which forms the subject of this paper,

appears in many problems relating to the flexure of solids, and has besides a kind of historical interest in virtue of Poisson's erroneous conclusion that it must be $\frac{1}{4}$ for all bodies.

Various methods have been employed to measure the ratio. The most obvious perhaps after direct measurement (which is obviously only applicable to a very small class of bodies) is to compare the times of longitudinal and torsional vibration of a wire or cylinder of the substance.

But as by this method $\mu=\frac{V_q^2-2V_n^2}{2V_n^2}$ where V_q and V_n are the velocities of the vibrations which depend on q and n respectively, it is easily seen that large errors may appear in the value deduced for μ when only comparatively small errors are made in the measurement of V_q and V_n, and besides this it is not unlikely that the q and n determined by vibrations, when there is not time for the heat caused by the strain to alter its distribution by conduction, may not be the same as when determined by statical methods. Wertheim made use of tubes closed at one end and filled with water, the surface of which appeared in a capillary tube fixed at the other end. The necessary data were obtained by subjecting the tubes to longitudinal strain, and observing the extension produced by it and the depression of the water in the capillary tube. Kirchhoff has employed an ingenious method in the case of brass and steel rods.

It depended on observing simultaneously the torsion and flexure produced by hanging a weight on an arm attached in a horizontal plane at right angles to one end of the rod, the other end of the rod being fixed in a horizontal position.

His experiments seem to have been made with every precaution against error, and the values he deduces for μ are ·294 for steel and ·387 for brass, both of which are larger than the values found in my experiments on the same metals.

This may be attributed in part, at any rate, to the fact that Kirchhoff used hardened steel and drawn brass rods, whereas most of my specimens were annealed.

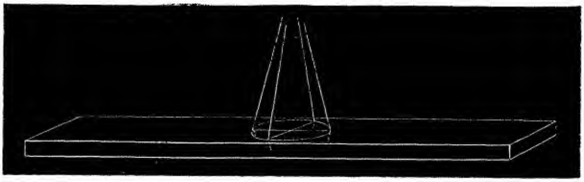
The method which I have employed has some advantages over these, especially in this that it is applicable to almost every solid, no matter how brittle it may be, or how narrow are its limits of elasticity.

It depends on the proposition that when a rectangular bar with plane sides is bent by opposing couples whose planes are parallel to one pair of sides, the other pair become surfaces of uniform anti-elastic curvature, with principal radii of curvature R and $\frac{-\mu}{R}$, provided that R is large compared with the third proportional to the thickness and breadth of the bar. (See Thomson and Tait "Nat. Phil.," § 716.)

If R_1 and R_2 are the radii of curvature parallel to the length and

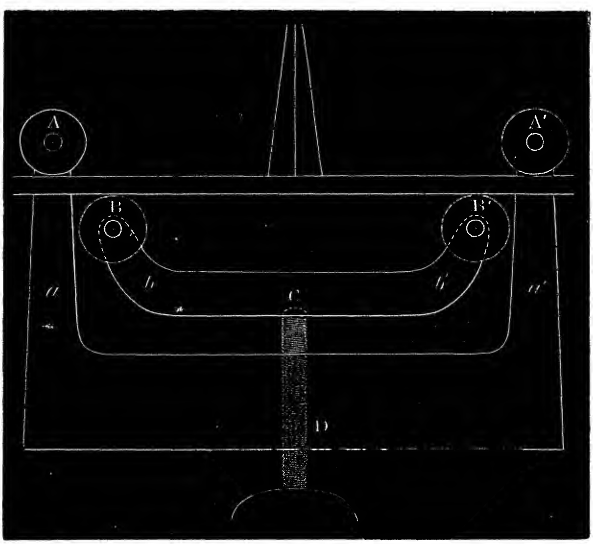
breadth of the bar respectively, $\mu=-\frac{R_1}{R_2}$, I measure this ratio as follows—

FIG. 1.



On one side of a rectangular bar, fig. 1, of the substance for which μ is to be measured, and about the middle of its length, a circle is described of diameter nearly equal to the breadth of the bar. Diameters are drawn in this circle parallel and perpendicular to the length of the bar, and at their extremities fine holes are drilled normal to the surface. (The dimensions of these holes are so small compared to those of the bar, that they do not sensibly affect the flexure.) Four fine steel wires of equal length are planted firmly in these holes, and their free ends are then bent together so that they may all be in the field of a microscope at the same time. The bar is then placed in a frame of which fig. 2 is a section.

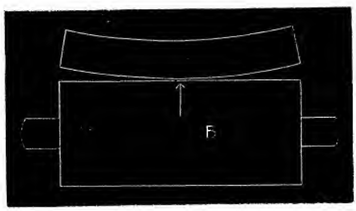
FIG. 2.



AA′ BB′ are pairs of rollers between which the bar is held. A and A′ are mounted on the outer frame *aa*′, BB′ on the frame *bb*′ which can be advanced towards AA′ by the screw D; this screw has

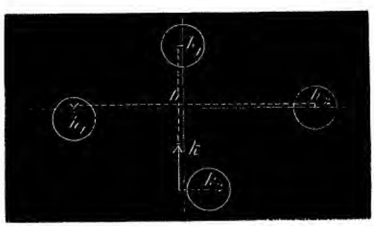
a spherical head fitting into a spherical cavity in bb' at C, and C is exactly half-way between A and A$'$, and B and B$'$. When the bar is bent in this frame by turning the screw D, the bending is accomplished by pure, equal, and opposite couples; for since AA$'$ BB$'$ are rollers and free to turn, there can be no tractions along the face of the bar, and therefore the pressures are normal to the surface, and the couples are equal in virtue of the equality of the distances AC A$'$C and BC B$'$C. Thus for that part of the bar between B and B$'$ the radii of curvature R_1 and R_2 are constant, except in so far as they may be affected by the surface distribution of pressure at B and B$'$ which as may readily be seen by the transverse section fig. 3, would tend

Fig. 3.



to make R_2 too large in the neighbourhood of the rollers; but the effect produced by this cause must be quite insignificant towards the middle of the bar. The whole frame aa' is mounted on a platform with screw motions parallel and perpendicular to the length of the bar, and the free ends of the wires are focussed in a fixed microscope,

Fig. 4.



Let h_1, h_2, k_1, k_2, fig. 4, be the ends of the wires. The distances (h_1h_2) (k_1k_2) resolved parallel and perpendicular to the length of the bar respectively, are measured by the screw motions, first, when the bar is unstrained, and again when it is bent by turning the screw D

Let h, k, h', k' be these distances, then if

ϵ=length of the wires,

r=radius of circle drawn on bar,

θ=angle made by the wire with the normal to bar,

the increment of the distance between h_1 and h_2 when the bar is bent,

or $h'-h$ is
$$\frac{2\epsilon r\cos\theta}{R_1},$$

and the decrement of the distance between k_1 and k_2 or $k-k'$ is

$$\frac{2\epsilon r \cos\theta}{R_2},$$

hence

$$\frac{k-k'}{h'-h}=-\frac{R_1}{R_2}=\mu.$$

The limit to the smallness of curvature which can be employed to measure μ by this method depends on the smallness of the interval which can be satisfactorily measured by the microscope and micrometer screw. In my experiments $h'-h$ varied from ·015 to ·03 inch, ϵ being about 3 inches and r nearly ·5 inch. These values would make R_1 vary from 200 inches upwards. The dimensions of the bars employed were about $8\times1\times{\cdot}25$ inches, so that the third proportional to the thickness, breadth (viz., 4 inches), fulfils the condition of being small compared to R. In fact, I found that much larger curvatures might be employed without sensibly altering the values obtained for μ.

My method admits of the determination of μ for substances which are not isotropic. Some examples of this are given in the table below in the case of the woods box, beech, and deal; μ_ρ, μ_σ, are the values of μ parallel and perpendicular to the radial plane of the tree, *i.e.*, the plane which contains the medullary fibres; μ_τ is the value in the plane cutting the axis of the tree at right angles.

It will be noticed that in all three cases μ_σ is greater than μ_ρ.

Beech-wood seems even to grow rather less dense in a radial direction under longitudinal pressure, but this is the only instance in which I found a value for μ greater than ·5.

Values of μ for various Substances.

Substance.	μ	μ_σ	μ_ρ	μ_τ
Steel	·253			
Brass	·325			
Copper	·348			
Lead	·375			
Zinc (rolled)	·180			
Ditto (cast)	·230			
Ebonite	·389			
Ivory	·50			
India-rubber	·50			
Paraffin	·50			
Plaster of Paris	·181			
Card-board	·2			
Cork	·00			
Box-wood	..	·42	·406	
Beech-wood	..	·53	·408	
Deal (white Pine)	..	·486	·372	·227

FIG. 1.

FIG. 2.

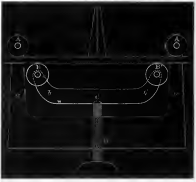


FIG. 3.

FIG. 4.